Measurements of D^0 and D^* production in p+p collisions at $\sqrt{s}$ = 510 GeV in STAR experiment

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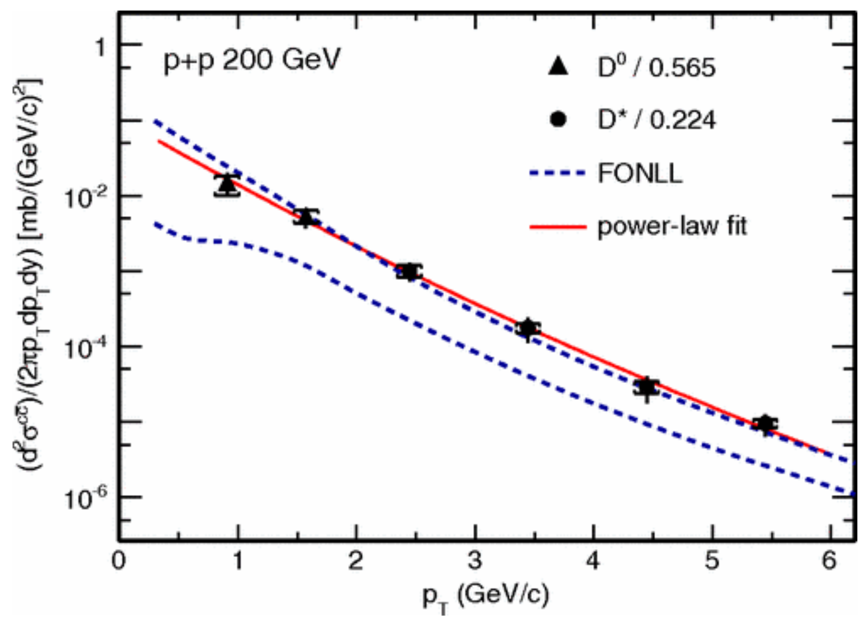
STAR

Introduction

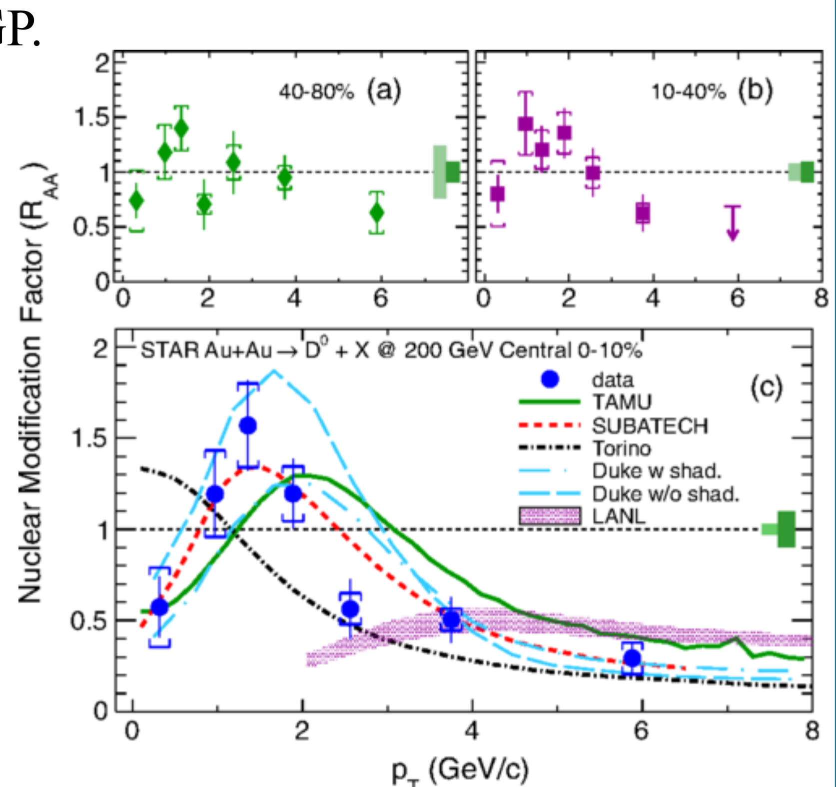
This poster is centered around an investigation into the production of D^0 and D* mesons as a function of transverse momentum (p_T) in proton-proton (p+p) collisions at a center-of-mass energy of $\sqrt{s}$ = 510 GeV conducted within the STAR experiment at the Relativistic Heavy Ion Collider (RHIC). The results of this analysis will serve to constrain the charm-anticharm production mechanisms in p+p collisions. We present the ongoing signal extractions of the D^0 and D* mesons from the minimum bias events recorded during the p+p collisions at $\sqrt{s}$ = 510 GeV at STAR in 2017.

Motivation

- Studying charm meson production allows for comparisons between experimental results and theoretical models (e.g., perturbative QCD, factorization frameworks).
- Modifications of the charm meson production in heavy-ion collisions with respect to p+p provide insights into QGP.



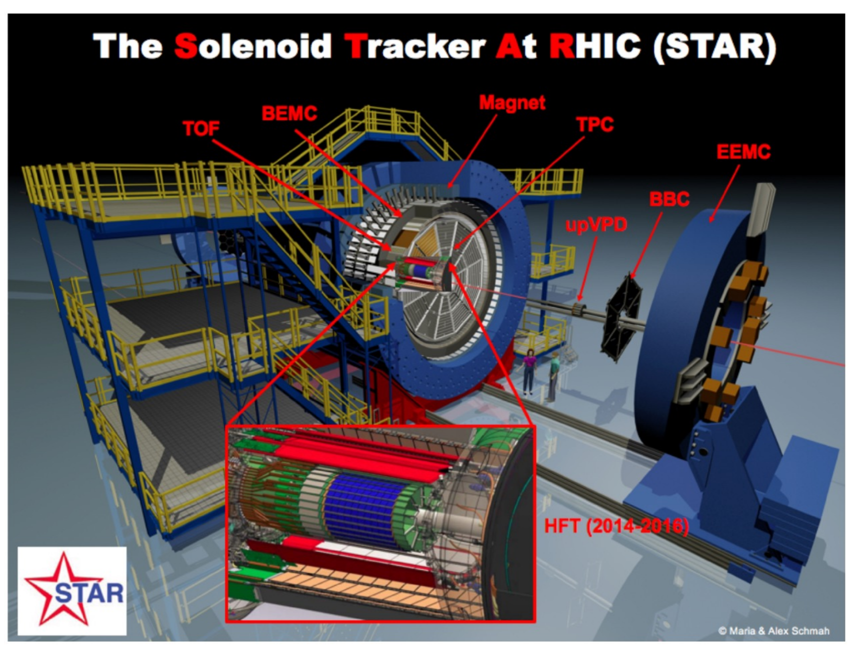
p_T-differential $c\bar{c}$ production cross sections compared with FONLL pQCD calculations [1]



D^0 meson nuclear modification factor R_{AA} [2]

STAR Detector

- The STAR detector is excellent in tracking and identifying charged particles at mid-rapidity ($|\eta| < 1$), while providing complete azimuthal coverage.
- The majority of the subsystems are situated within a solenoidal magnetic field of 0.5 T.



- Vertex Position Detector (VPD) to trigger minimum bias events and removing pileup vertices.
- Time Projection Chamber (TPC): main tracking detector, momentum determination, particle identification via ionization energy loss (dE/dx).
- Time Of Flight (TOF): particle identification via velocity (β).

Analysis Method

- About 1.11 billion minimum bias p+p events at $\sqrt{s}$ = 510 GeV recorded in 2017 are used in this analysis.
- Hadronic decay channels are used to reconstruct D^0 and D*.

$$D^0(\bar{D}^0) \xrightarrow{B.R.=3.947\%} K^{\mp}\pi^{\pm} \;;\; D^{*\pm} \xrightarrow{B.R.=67.7\%} D^0(\bar{D}^0)\pi_s^{\pm} \xrightarrow{B.R.=3.947\%} K^{\mp}\pi^{\pm}\pi_s^{\pm}$$

Event Selection

$\lvert V_{z[TPC]} - V_{z[VPD]} \rvert$	< 4.0 cm
$V_{z[TPC]}$	< 60 cm
$V_{x[TPC]}$	(−0.3, 0.14) cm
$V_{y[TPC]}$	(−0.26, 0.02) cm

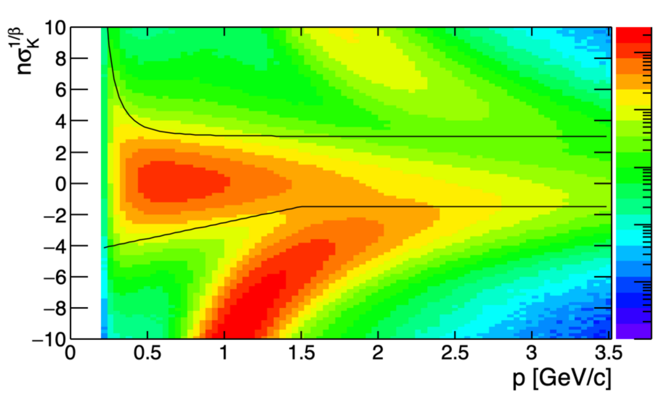
Track Quality Cuts

number of TPC fit points	> 18
$\frac{\text{number of TPC fit points}}{\text{number of max possible TPC fit points}}$	> 0.52
global DCA	< 1.5 cm
p_T	> 0.2 GeV/c
$\lvert\eta\rvert$	< 1

PID

	$p_T \leq 1.6$ GeV/c	$p_T > 1.6$ GeV/c
Kaons	$-2.5 < n\sigma_K^{dE/dx} < 3.0$ p dependent cut on $n\sigma_K^{1/\beta}$	$-2.5 < n\sigma_K^{dE/dx} < 3.0$ p dependent cut on $n\sigma_K^{1/\beta}$
Pions	$-3.0 < n\sigma_\pi^{dE/dx} < 3.0$ p dependent cut on $n\sigma_\pi^{1/\beta}$	$-3.0 < n\sigma_\pi^{dE/dx} < 3.0$ if TOF matched p dependent cut on $n\sigma_\pi^{1/\beta}$ if TOF matched $-2.5 < n\sigma_\pi^{dE/dx} < 2.5$ if no TOF info

D^0 daughter Kaon and Pion PID Cuts



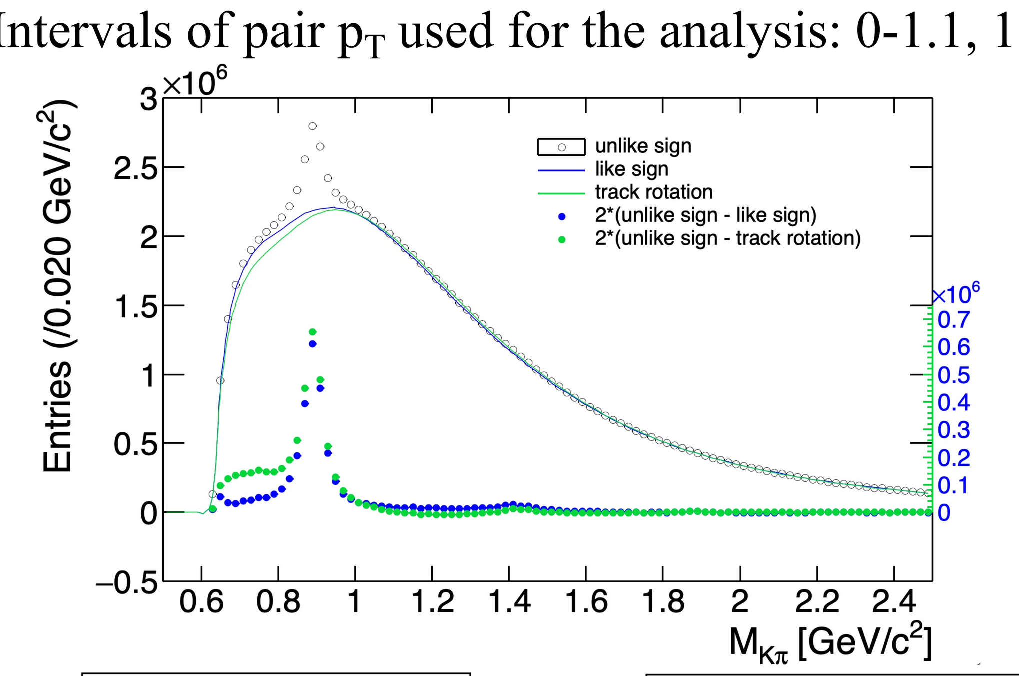
For Soft Pion (π_s) identification, TOF pion cut was loosened for p < 1.6 GeV/c to select more low momentum tracks.

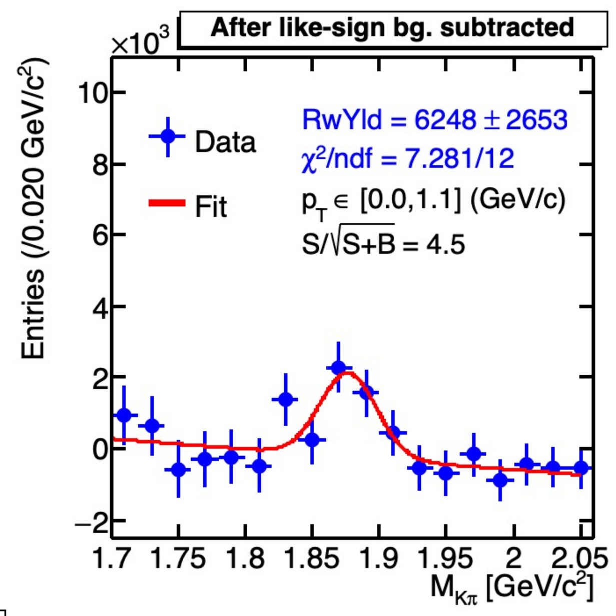
References

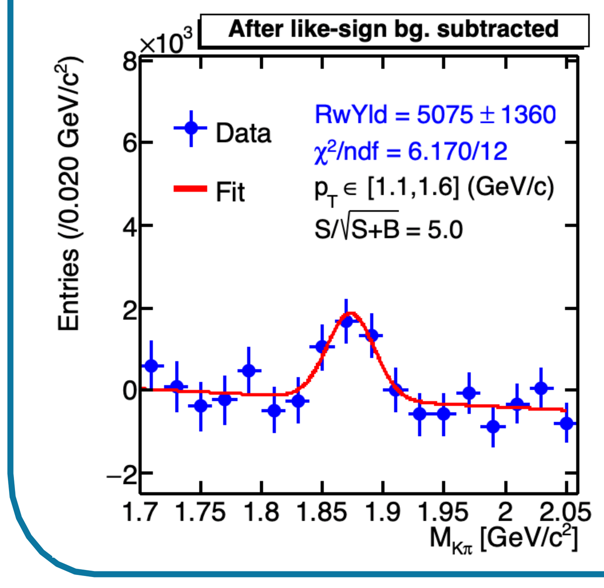
1. L. Adamczyk et. al. (STAR Collaboration), 2012, Phys. Rev. D 86, 072013.
2. L. Adamczyk et. at. (STAR Collaboration), 2014, Phys. Rev. Lett. 113, 142301

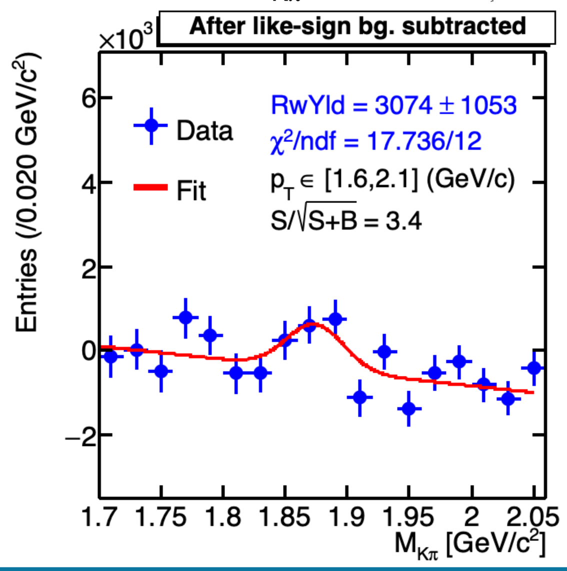
D^0 Signal Extraction

- Unlike-sign pions and kaons were paired [$K^-\pi^+$, $K^+\pi^-$].
- Two independent background estimation methods were deployed for D^0 signal extraction :
  - like-sign pairs [$K^-\pi^-$, $K^+\pi^+$]
  - track-rotation method [pion tracks are paired with kaon tracks with reversed 3-momentum (180° rotation)]
- Intervals of pair p_T used for the analysis: 0-1.1, 1.1-1.6, 1.6-2.1 GeV/c.





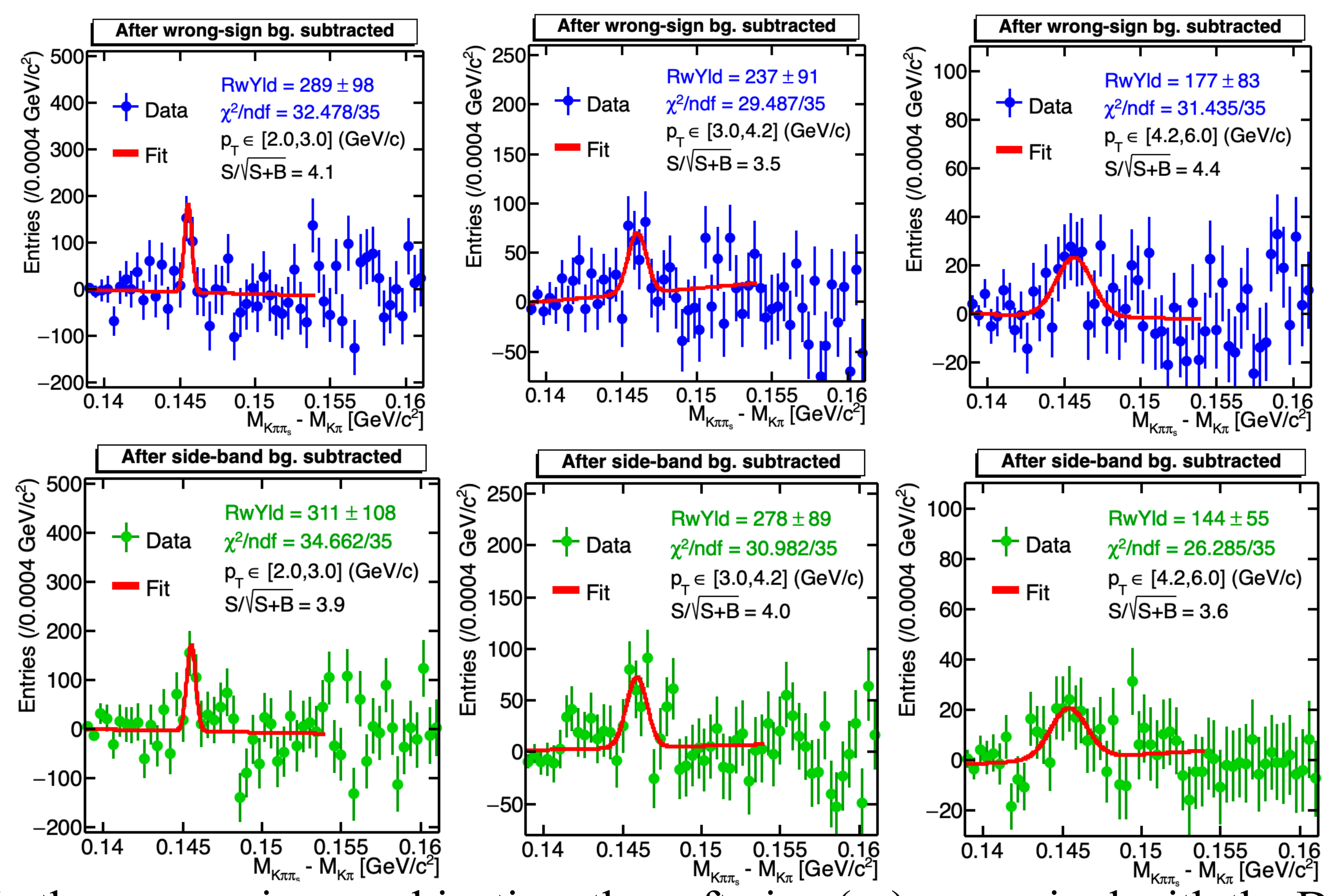




- Background subtracted data were fitted with Gaussian + linear function.
- Raw Yield is extracted from the area under the fitted Gaussian.

D^* Signal Extraction

- Histogram was populated with the mass difference $M_{K\pi\pi_s}$ - $M_{K\pi}$.
- Wrong-sign combination and side-band method were used to reconstruct background to extract the D* signal.
- Intervals of the triplet p_T used here are: 2-3, 3-4.2, 4.2-6 GeV/c.



- In the wrong-sign combination, the soft pion (π_s) was paired with the D^0 daughter pion of the opposite charge. In the side-band method, the $M_{K\pi}$ had been lying between two side-bands: 1.64 - 1.74 GeV/c² and 2.01 - 2.11 GeV/c², i.e. outside the D^0 mass window.

Summary and Outlook

- D^0 and D* signals were extracted up to p_T of 2.1 GeV/c and 6.0 GeV/c, respectively using Minimum Bias p+p data at 510 GeV.
- Analyses were performed with two independent background estimation methods.
- Efficiency and systematic uncertainties to be determined next for cross-section calculation.
- Barrel High Tower triggered data is also being analyzed currently for raw yield measurements at higher p_T.

Acknowledgement

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